Structure of nanocrystalline and amorphous materials from electron diffraction in the TEM

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Electron diffraction from thin films can be recorded in the TEM with either convergent beam (CBED) or parallel beam (SAED, NBD) illumination. Although CBED carries a wealth of information from single crystalline regions, parallel illumination is preferred for the structure examination of either nanocrystalline (nc) or amorphous thin films. Both the sharp rings in the former case and the diffuse rings in the latter case can be quantitatively analysed with the ProcessDiffraction program, which is distributed free of charge [1]. Both the volume fractions and the possible preferred orientation of the nc phases can be quantified with this program [2-4]. The short range order for either nc or amorphous materials can be determined with that program [5-7 volt meg egy cikk ahol hasznaltam amorfra]. When Bragg reflections are analysed it gives the global structure, while the pair distribution function (PDF) provides the local structure. Differences between local and global structures are exemplified e.g. in [8].

Recently, a possibility was implemented in ProcessDiffraction to apply a “Mask”, i.e. to disregard pre-selected parts of the pattern from processing. In addition to eliminating the possible distortion in the ring-averages caused by the presence of “Beam-stop”, the Mask also facilitates separation of incoherently superposed components, like the sc?-spots originated from traces of the not-completely removed substrate when the ring pattern from the layer is to be analysed. The example in Fig. 1 shows the effect of masking, while Fig. 2 demonstrates the change in lattice parameter due to mutual solution of the two phase-components (AlN and TiN) in each other. Refinement of such lattice parameter changes is also included in the program.

The talk will also include examples from determination of local structure through PDF-analysis. Special problems of calibration, scattered radiation when using selected area aperture and possible distortions of lenses as a function of lens settings are also discussed. These problems are more serious in PDF-analysis than in evaluation of Bragg-reflections.

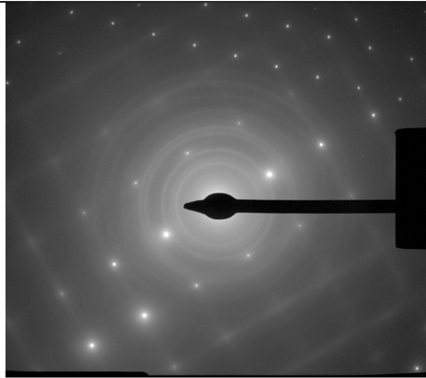

Figure 1.a: Original measured pattern on a logarithmic scale.

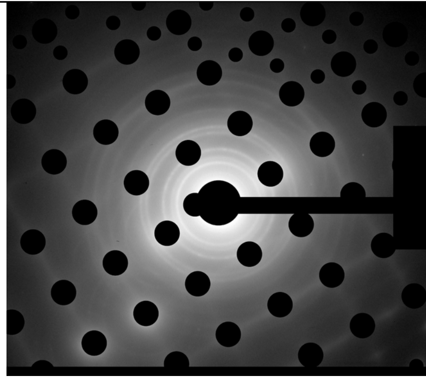

Figure 1.b: Masked pattern in a logarithmic scale.

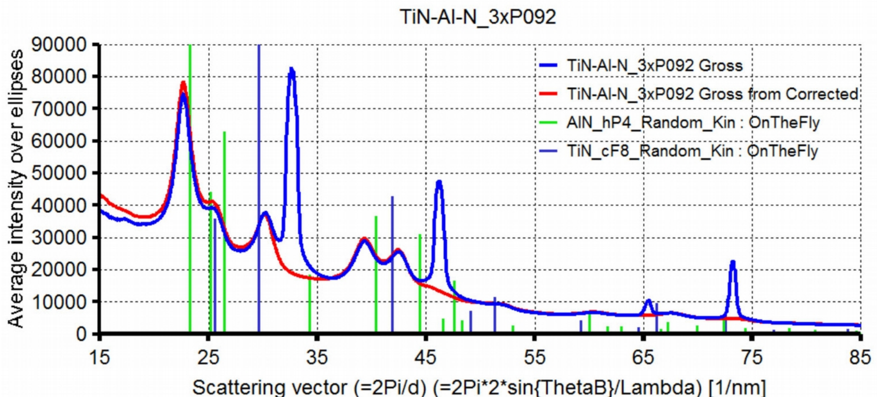

Figure 2: Distribution calibrated to the diffraction lines of the substrate (Si). The two nc components are shifted in opposite directions due to mutual dissolution.

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